FOR IMMEDIATE RELEASE
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ESPLANADE ACOUSTICS WINS TOP ENGINEERING AWARD

Medicine Hat – The Esplanade Arts and Heritage Centre was recognized in Ottawa last week with the Schreyer Award. Created by Governor General Ed Schreyer in 1982, the Schreyer is Canada's highest distinction for engineering.

Aercoustics Engineering Limited was responsible for the acoustics in the Esplanade Theatres, working along with architects Diamond Schmitt Architects Inc. The building is owned and operated by the City of Medicine Hat.

The award citation focuses on two innovations introduced during the design of The Esplanade: *small scale acoustic modelling* and *noise control*.

Small Scale Acoustic Modelling
Prior to their work on The Esplanade, Aercoustics had spent two and a half years developing software to facilitate small scale acoustic modelling.

"Modern computer modelling – where the model exists only in the computer – is very powerful but it does have limitations," explains John O'Keefe of Aercoustics Engineering Limited.

For different reasons, what that used to mean was that you had to build a model as big as a bedroom. The software that Aercoustics developed allows them to study much smaller models and, most importantly, to accurately "listen" to a room before it is built. The software tests a small scale physical model with an actual audio signal.

"We call (the software) Renaissance because it recovers the original acoustic signal that has been contaminated by the effects of the atmosphere, microphones, etc.," adds O'Keefe.

O'Keefe says, "It proved to be just the tool for the job. The computer model was predicting disaster, telling us that the room needed to be four meters taller, and the scale model suggested everything was going to be great with the height the way it was. During the design we had to choose which story to believe. Had we chosen the computer model's version, the building would have been a lot less than it is. And it would have cost a lot more. We went with the scale model and the result is one of our best sounding rooms yet. The room was built without increasing the height, and the performance tests indicated nearly exactly the same results as the small scale model software test indicated."

Noise Control
The second innovation addressed issues of noise control.

"Actors and musicians need a quiet room in the same way that an artist needs a clean canvas", says O'Keefe.

The noise control methods developed for the Esplanade were later used on the Four Seasons Centre for the Performing Arts, currently the quietest opera house in the world.

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Attached: ***Acoustic Design of the Esplanade Arts and Heritage Centre***, Canadian Consulting Engineer, October/November 2007

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Acoustic Design of the Esplanade Arts and Heritage Centre

A theatre in Medicine Hat, Alberta has achieved the highest levels of sound quality thanks to sophisticated anaylis and wise judgement by Aercoustics Engineering.

The $32-million Esplanade Arts and Heritage Centre in Medicine Hat, Alberta opened in October 2005. It consists of a museum, a 150-seat studio theatre and the 700-seat main auditorium.

Aercoustics Engineering of Toronto was responsible for the acoustic design of the auditoria. They introduced two significant innovations in acoustical analysis. First, they developed signal conditioning software to analyze sound in small-scale models. Second, they developed ways to analyze noise from the auditorium's displacement ventilation system.

Analysis for a small-scale building model

The design of the Esplanade saw the first application of the Renaissance acoustic modeling software. Developed by Aercoustics over two and a half years, Renaissance is a series of signal conditioning algorithms for small scale acoustic modeling.

Small scale acoustic models – in this case 1:20 – are easier to build than the traditional 1:8 or 1:10 scale models. The acoustic analysis of small scale models, however, is fraught with difficulties. Smaller scale models, for example, require measurements at higher ultrasonic frequencies where the dissipative effects of water molecules must be compensated for.

The commercially available software that would account for small scale modeling difficulties only provided compensation in the energy domain i.e. squared sound pressure. As a consequence, the acoustic analysis was limited to the study of numbers and graphs.

Acoustical engineers also need to *hear* things. For this, a linear representation of the sound pressure is required. This means that the reactive (imaginary) component of the signal must be recovered.

While numbers and graphs can be accurately studied in a signal-to-noise ratio environment of 25 to 30 decibels, our hearing has a dynamic range of more than 90 decibels. Signal conditioning is required to artificially, yet accurately, extend the dynamic range of the sound decay.

The Renaissance package deals with all the above difficulties. It was based on Vincent Grillon's Ph.D. thesis, "Auralisation dans les Maquettes: Traitement des Response Impulsionelle." The software now consists of a collection of 41 Matlab routines and more than 5,600 lines of computer code.

A low "acoustically transparent" ceiling

The architect desired a low, "acoustically transparent" ceiling, i.e. one that the sound could penetrate, but which presented a visual barrier so the audience could not see the catwalks and rigging. This requirement presented a challenge beyond the capabilities of modern computer modeling algorithms.

Consequently, a physical scale model using an assembly of wooden dowels as the ceiling was built and tested. The ability to "listen" to how the ceiling affected sound incident at small grazing angles proved critical in refining the architectural design.

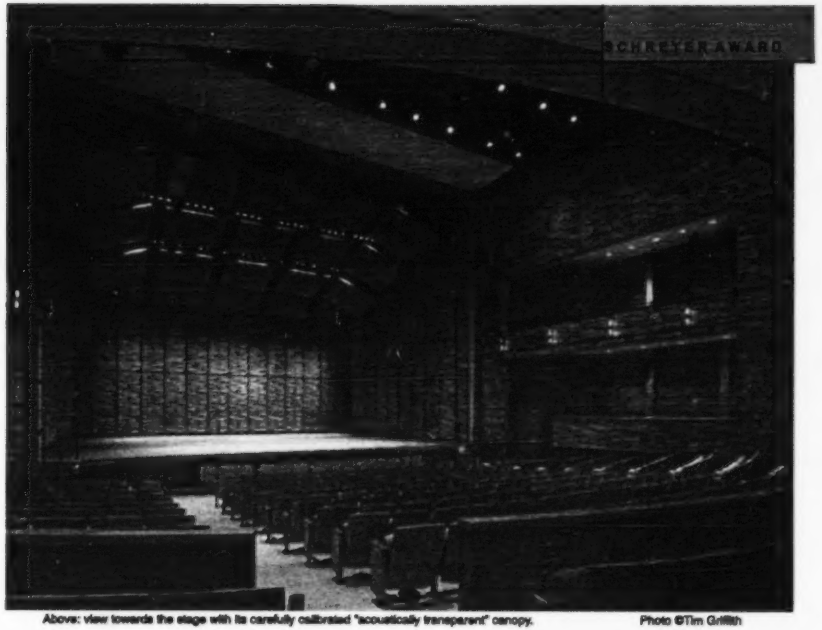
The scale model studies also brought unexpected results. To achieve the proper reverberance – according to the computer model – the height of the building would have to be raised by 4 metres or more. But the scale model suggested otherwise, even though it wasn't fully calibrated for this type of measurement. Simple spreadsheet calculations and Aercoustics' engineering experience also disagreed with the computer model.

It was decided to leave the building height as it was. Though this was a nerve-wracking decision, when the building was commissioned and the engineers performed acoustical measurements, the results matched the scale model almost exactly.

Analyzing sound from displacement ventilation

The cornerstone of good acoustics is a quiet background noise level. Musicians and actors need a quiet room in the same way that a painter needs a clean white canvas. Most of the noise generated inside this or any kind of building comes from the ventilation system.

The Esplanade, like many new performing arts centres, uses a displacement system to ventilate the room.



Above: view towards the stage with its carefully calibrated "acoustically transparent" canopy. Photo ©Tim Griffith

These systems have become popular, but to date there was no recognized method of predicting or measuring their acoustical performance. Analyzing plenum noise control presents a dilemma. Line of sight is important in noise control: the more visible a source is, the louder it will be heard. But the acoustical analysis is complex: a listener in the orchestra level can see only four or five noise sources. A listener on a catwalk, however, can see several hundred noise sources. An appropriate analysis, of course, must consider both listener scenarios. But how?

The beauty of the solution is in its simplicity. The listener on the orchestra level is close to the noise sources while the listener on the catwalk is far way. Thus, the analysis can be conveniently broken down into near and far field solutions. Prediction and measurement procedures were developed accordingly. Though the procedures were used for analysis only at the Esplanade Centre, they directly influenced the noise control design for the Four Seasons Centre for Performing Arts in Toronto, designed to the threshold of hearing NI Criterion.

As for the Esplanade Centre, it has won accolades. Carol Beatty, manager of cultural development at the centre, says: "Performers from across the country have raved about the acoustics, and in fact believe we have one of the best acoustic performance spaces in western Canada."

Name of project: Acoustic design of the Esplanade Arts & Heritage Centre
Award-winning firm: Aercoustics Engineering, Toronto (John O'Keefe, P.Eng., Kiyoshi Kuroiwa)
Role of award-winner: acoustical engineer
Owner: City of Medicine Hat
Client/architect: Diamond Schmitt Architects Inc.
Associate architect: Cohos Evamy
Other key players: Engineering Harmonics (sound system), Fisher Dachs (theatre consultant), Crossey Engineering (mechanical & electrical), Halcrow Yolles (structural/building envelope), Ellis Don (contractor), LMDG (building code)